

Quantum Mechanics of Macroscopic Variables

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Although the quantum tunneling in macroscopic systems with one degree of freedom has been confirmed by many experiments the question of whether it occurs in two-dimensional (2D) macroscopic systems as predicted by the theory of quantum mechanics has not been carefully tested until our recent experiment. We measured the escape of the “phase” particle from a 2D potential of dc superconducting quantum interference device. When temperature is lower than 0.2 K, the data agrees quantitatively very well with the theory, demonstrating the quantum nature of micro-fabricated electronic devices and their potential applications in quantum information process.

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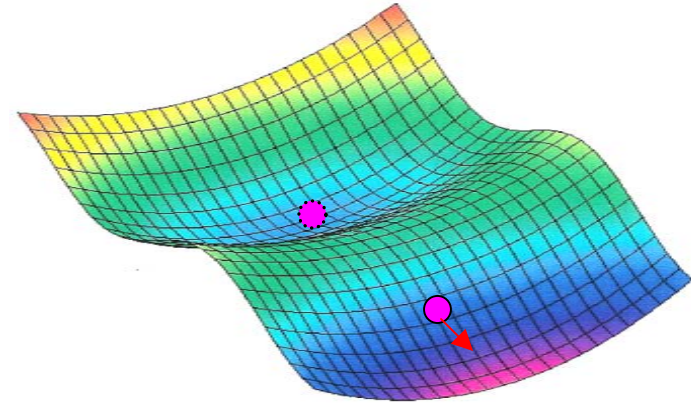


Figure 1. The two-dimensional potential landscape of a superconducting quantum interference device (dc SQUID). The Phase particle escapes from the metastable potential well by tunneling under the barrier.

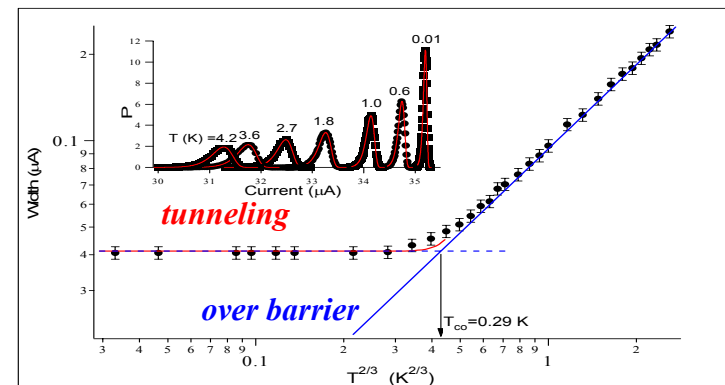


Figure 2. Quantitatively, the experimental data (dots) and theory (lines) agree very well.

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Education:

- One undergraduate (Matthew Matheny), three graduate student (Yang Yu, Yu Zhang, and Wei Qiu), and one postdoc (Shaoxiong Li) contributed to this work.
- Matt received KU's Undergraduate Summer Research Scholarships in 2002.
- Yu Zhang received her M.S. in 2001 and currently is enrolled in physics Ph.D. program at Northwestern University.
- Yang Yu received his Ph.D. in 2002 and is presently a postdoc at the Massachusetts Institute of Technology (MIT).

Outreach:

The PI conducted lab tours, introduced superconductivity, and demonstrated its effect as a guest speaker for the science class of local elementary school students. The PI also gave talks on quantum mechanics and its applications, such as quantum information processing and quantum computing, to the SPS chapters at the University of Virginia and the University of Kansas.



Figure 3. Shaoxiong (right) and Wei (left) are preparing the dilution fridge for the experiment demonstrating quantum mechanical nature of electrical current in a superconducting loop.